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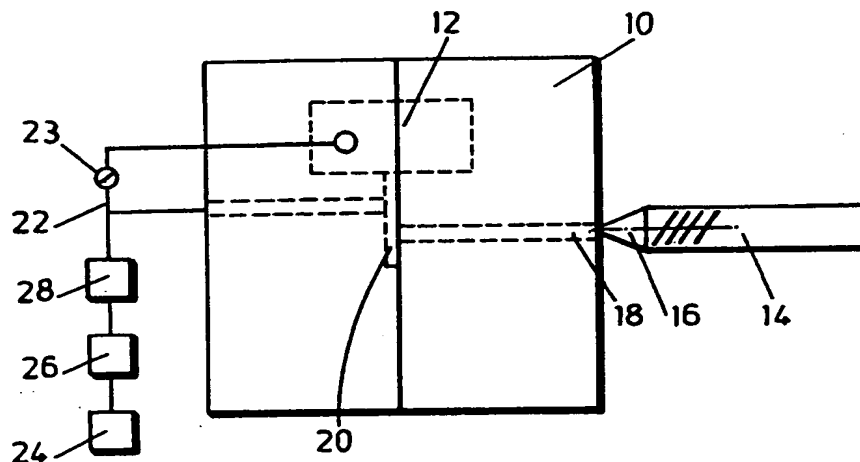
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(54) Abstract Title

Method and apparatus for injection moulding

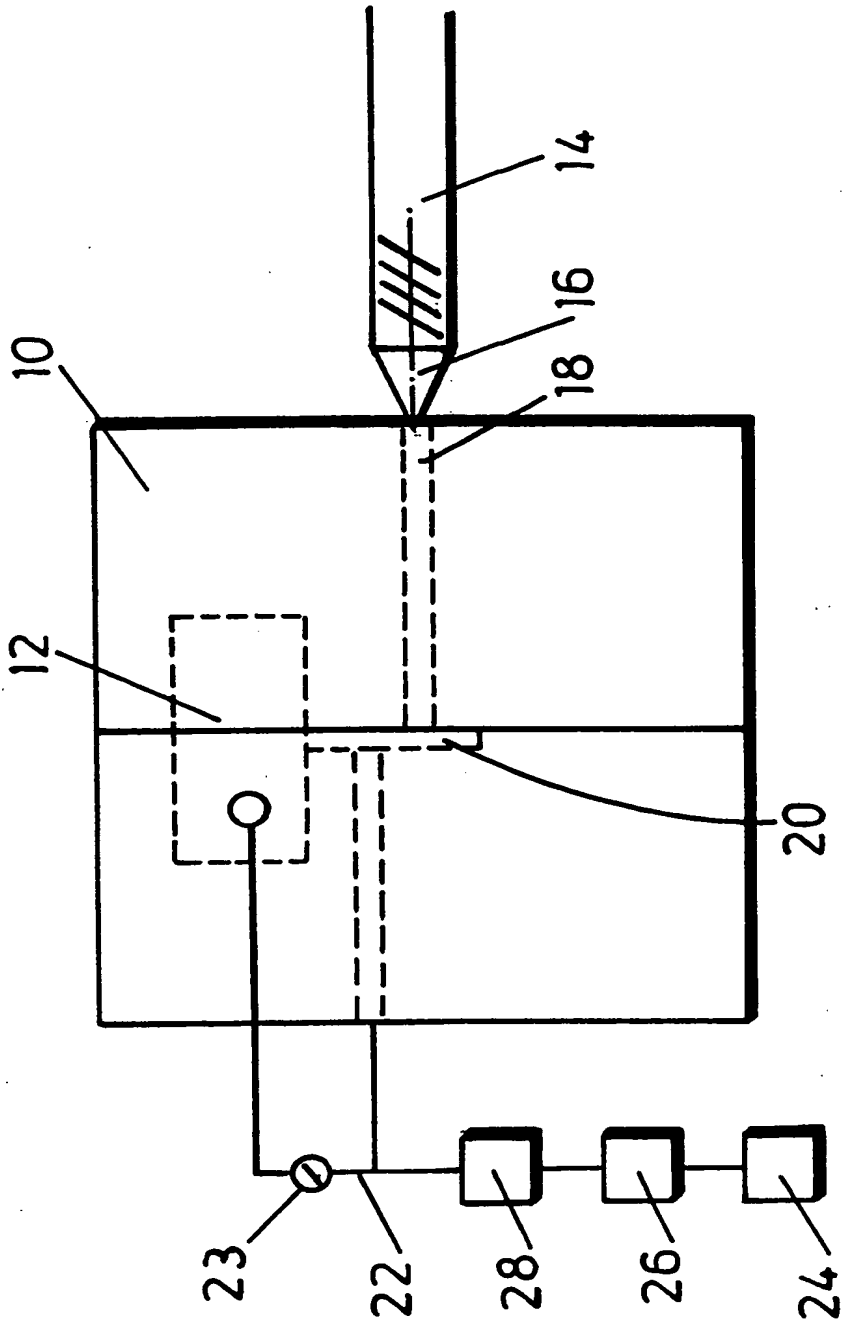
(57) A method and apparatus for moulding articles from plastics material uses insertion of a substance in a less mobile state, for example, liquid nitrogen or solid carbon dioxide, into the molten plastics material, whereby that substance absorbs heat from the plastics material to expand into a more mobile state and force the plastics material against mould cavity walls.



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TITLE: Method and apparatus for injection moulding of plastics material.

DESCRIPTION

This invention concerns a method and apparatus for injection moulding of plastics material.

Injection moulding is a common technique for producing shaped articles from thermoplastics material. The thermoplastics material is heated into a molten condition and injected under pressure through a nozzle into a mould cavity. The thermoplastics material is allowed to cool sufficiently to harden, so that the mould can be opened and the hardened article removed. Unfortunately, in some instances surface distortions can occur in the moulded article due to shrinkage during hardening or as a result of uneven pressure gradients across the mould from the mould gate to extreme parts of the mould. To try to reduce the occurrence of surface distortions, it is now known to use gas injection during the injection moulding, in which an inert gas, such as nitrogen, is injected through the plastics material injection nozzle and directly into the thick areas of the molten thermoplastics material in order to create hollows in the moulded article. The effect of the inert gas injection is to provide additional force to expand the molten thermoplastics material substantially evenly into all parts of the mould internal wall. In that way, surface distortions due to shrinkage and uneven pressure gradients can be substantially eliminated.

However, there is still a delay during the moulding process while the molten

thermoplastics material is allowed to harden before the mould can be opened and the moulded article removed. Clearly moulding throughput can be improved if the cooling process can be accelerated. That is one area of the injection moulding process that the present invention seeks to improve.

According to a first aspect of the present invention there is provided a method for moulding articles from plastics material comprising the steps of injecting molten plastics material into a mould cavity under pressure and applying to the molten plastics material in the mould cavity a substance in a less mobile state, whereby said substance on being heated by the molten plastics material expands into a more highly mobile state to increase pressure exerted on or within the plastics material and to force it onto walls of the mould cavity.

According to a second aspect of the invention there is provided an apparatus for moulding plastics material into an article comprising a mould having a cavity with a wall shape corresponding to the shape of the article to be formed, means for injecting molten plastics material into the mould cavity and means for applying to the molten plastics material a substance in a less mobile state, whereby upon absorption of heat from the molten plastics material, the substance is converted into a more highly mobile state to force the plastics material against walls of the mould cavity.

The term "plastics material" as used herein is intended to cover any such material that can be supplied in a flowable state and includes thermoplastics and some thermosetting materials.

In one form of moulding the application of the less mobile state substance can be into the molten plastics material in order to create a hollow within the material and

force it against the cavity walls. In another form of moulding the less mobile state substance may be applied against the molten material to force it against a mould cavity wall from behind.

The substance to be applied into the molten plastics material may be in solid form or in liquid form, although the latter is preferred. If the substance to be used in its lower mobile state is a solid, it is preferably one that will sublime on being heated, such as, for example, solid carbon dioxide. However, it is preferable to use a substance that is gaseous at normal temperatures, such as, for example, liquid nitrogen. By delivering, for example, liquid nitrogen to the molten plastics material in the mould, two effects are created. The first effect is the absorption of heat from the molten material by the liquid whereby it becomes a gas and exerts pressure on the molten material and the second consequential effect is that more rapid cooling of the molten material occurs.

The amount of the solid or liquid substance to be applied to the molten plastics material may depend on the temperature at which the molten plastics material is introduced into the mould and the pressure required within or on the molten plastics material to force the molten material against the cavity walls to a desired extent. The amount of the substance to be inserted into the plastics material may be calculated on the basis of these two factors.

For practical purposes the apparatus of the invention preferably includes a delivery system for the substance to be applied that is insulated to inhibit any change of state prior to the mould. The delivery system preferably includes a pump and a valve, whereby delivery pressure and timing may be controlled. Furthermore, the

apparatus of the invention may also include an evacuation port to permit the expanded substance to vent before the mould is opened and the moulded article removed from the mould. The evacuation port may return the now gaseous substance to a compressor to convert it back to liquid or solid form for re-use in the moulding process.

This invention will now be further described, by way of example only, with reference to the accompanying drawing, which shows schematically a moulded apparatus according to the invention.

Referring to the accompanying drawing, a moulding apparatus comprises a mould 10 having a cavity 12, a screw feed 14, nozzle 16 and sprue feed 18 for injecting molten thermoplastics material under pressure via a runner 20. A substance in a low mobile state may be applied to the thermoplastics material in various ways. A supply line 22 includes a container 24 of the low mobile state substance, typically liquid nitrogen, a pump 26 and a valve 28, whereby the delivery pressure and timing can be controlled. The supply line 18 can be connected to the runner 20 or directly to the mould cavity depending on valve 23. The point of supply will depend on whether the low mobile state substance is required to form a hollow within the molten plastics or to apply a force behind the molten plastics to press it onto a mould face. The supply line will be insulated to maintain the low mobile state substance in that state or at least until it enters the mould.

To produce a moulded article in the apparatus illustrated, molten thermoplastics material, for example, is fed into the mould cavity under pressure by means of the screw. When the mould is filled or partially filled, the pressure is

maintained from the screw but a substance in a low mobile state, such as solid carbon dioxide or liquid nitrogen is applied to the molten plastics material. The substance applied to the molten plastics material absorbs heat from the molten material, which converts it into a more mobile state i.e. if a solid it sublimates to become a gas or a liquid it becomes a gas. Accordingly, the substance expands and exerts pressure upon or within the molten plastics material to force it against the walls of the mould cavity. Conversely, the absorption of heat from the molten plastics material accelerates the solidifying process, so that the mould can be opened more quickly and the moulded article removed ready for the next injection of molten plastics material into the mould.

To give a specific example a mould of 5cm^3 having an internal hollow volume of 103cm^3 is to be used to make a hollow moulding from 21.47cm^3 of plastics material to have a wall thickness of 1.5mm. By injecting liquid nitrogen at pressure of 100psi into molten plastics material at 200°C the liquid nitrogen converts to gas and exerts a pressure of 169psi and the molten plastics material is cooled down to 0°C .

CLAIMS

1. A method for moulding articles from plastics material comprising the steps of injecting molten plastics material into a mould cavity under pressure and applying to the molten plastics material in the mould cavity a substance in a less mobile state, whereby said substance on being heated by the molten plastics material expands into a more highly mobile state to increase pressure exerted on or within the plastics material and to force it onto walls of the mould cavity.
2. A method as claimed in claim 1, wherein application of the less mobile state substance is into the molten plastics material to create a hollow within the material and force it against cavity walls.
3. A method as claimed in claim 1, wherein application of the less mobile state substance is against the molten material to force it against a mould cavity wall from behind.
4. A method as claimed in claim 1, 2 or 3, wherein the substance to be applied to the molten plastics material is in solid form.
5. A method as claimed in claim 4, wherein the solid substance is solid carbon dioxide.
6. A method as claimed in claim 1, 2 or 3, wherein the substance to be applied to the molten plastics material is a liquid that is gaseous at normal temperatures.
7. A method as claimed in claim 6, wherein the liquid substance is liquid nitrogen.
8. Apparatus for moulding plastics material into an article comprising a mould

having a cavity with a wall corresponding to the shape of the article to be formed, means for injecting molten plastics material into the mould cavity and means for applying to the molten plastics material a substance in a less mobile state, whereupon absorption of heat from the molten plastics material, the substance is converted into a more highly mobile state to force the plastics material against walls of the mould cavity.

9. Apparatus as claimed in claim 8 comprising means for inserting the less mobile state substance into the molten plastics material.

10. Apparatus as claimed in claim 8 or 9, wherein the less mobile state substance is a solid.

11. Apparatus as claimed in claim 10, wherein the solid substance is solid carbon dioxide.

12. Apparatus as claimed in claim 8 or 9, wherein the less mobile state substance is a liquid.

13. Apparatus as claimed in claim 12, wherein the liquid substance is liquid nitrogen.

14. Apparatus as claimed in any one of claims 8 to 13, including a delivery system for the less mobile state substance that is insulated to inhibit any change of state prior to the mould.

15. Apparatus as claimed in claim 14, wherein the delivery system includes a pump and a valve, delivery pressure and timing are controllable.

16. Apparatus as claimed in any one of claim 8 to 15 further comprising an evacuation port to permit escape of the substance in its more mobile state.

17. Apparatus as claimed in claim 16, wherein the evacuation port is connected to a compressor to return the substance to its less mobile state for re-use.

18. A method for moulding articles from plastics material substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

19. Apparatus for moulding plastics material substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.



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Claims searched: 1-19

Examiner: J P Leighton
Date of search: 8 May 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): B5A(AD25, AD28, AD34, AT14P)

Int Cl (Ed.6): B29C(45/00, 45/17)

Other: Online:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2260099A	Peguform-Werke GmbH see whole disclosure	8,9,12-14 at least
X	GB2232632A	Asahi Kasei KKK - see whole disclosure	"
X	GB2139548A	J W Hendry - see page 1 lines 84-95	1 & 8 at least
X	GB1549940A	R Hanning - see whole disclosure	1 & 8 at least
X	EP0714745A1	Cheil Industries - see col.2 lines 24-59	1 & 8 at least
X	US5139714A	Siebolt Hettinga - see col.2 lines 40-50	1 at least

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.

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